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Feasibility study for a recirculating linac-based facility for femtosecond dynamics

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Abstract

LBNL is pursuing design studies and the scientific program for a facility dedicated to the production of x-ray pulses with ultra-short time duration, for application in dynamical studies of processes in physics, biology, and chemistry. The proposed x-ray facility has the short x-ray pulse length (~60 fs FWHM) necessary to study very fast dynamics, high flux (up to approximately 10^{11} photons/sec/0.1%BW) to study weakly scattering systems, and tuneability over 1-12 keV photon energy. The hard x-ray photon production section of the machine accomodates seven 2-m long undulators. Design studies for longer wavelength sources, using high-gain harmonic generation, are in progress. The x-ray pulse repetition rate of 10 kHz is matched to studies of dynamical processes (initiated by ultra-short laser pulses) that typically have a long recovery time or are not generally cyclic or reversible and need time to allow relaxation, replacement, or flow of the sample. The technique for producing ultra-short x-ray pulses uses relatively long electron bunches to minimise high-peak-current collective effects, and the ultimate x-ray duration is achieved by a combination of bunch manipulation and optical compression. Synchronization of x-ray pulses to sample excitation signals is expected to be of order 50 - 100 fs. Techniques for making use of the recirculating geometry to provide beam-based signals from early passes through the machine are being studied.

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